# NOTES ON OCEANOGRAPHY.

BY

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THE PHYSIOGRAPHIC PROBLEMS OF SALINITY AND TEMPERATURE IN THE PACIFIC OCEAN.—A. LINDENKOHL, U. S. COAST AND GEODETIC SURVEY, in *Petermanns Mitteilungen, Vol. 45, p. 4.*

I.—BERING SEA.—The low surface density, 1.0241 in. in Bering Sea, is due to abundant condensation and large river flow. The author does not mention melting ice, but it should undoubtedly be included as a cause.

The high density, 1.0261, at the bottom, 3,654 metres, of the same body of water, is attributed to the under-currents from the main Pacific. This forms a contrast to what takes place in the Mediterranean, where the slight depth of the Straits of Gibraltar prevents the escape of the dense waters of that body to the Atlantic. The deep passage ways between the Aleutian Islands and Kamchatka (3,654 m. to 5,700) serve to introduce a large body of warmer and denser water into this basin.

There is a rapid decrease in the temperature of this body of water down to 100 m., then an increase down to 400 m., which becomes stationary to 800 m., and this followed by a very gradual decrease to 1.5° at a depth of 2,129 m.

This gradual decrease indicates plainly that we are not dealing with an enclosed body of water, such as (the Mediterranean or) the Gulf of Mexico, where there is no decrease beyond a given low temperature determined by the form of the basin.

The rise, even though it is small between 100 and 400 m., shows that it has some connection with the warmer currents of the N. W. Pacific, and not with the surface waters.

II.—SEA OF OKHOTSK.—The greatest depth of this sea is 3,370 m. (Lat. 47° 80′ and 149° 42′ W. Lon.) near the chain of the Kurile Islands, from which there is a gradual decrease in depth towards Sakhalin Island.

A phenomenon contrary to ordinary experience is noticed in a body of water from the 50th to the 200th metre-line in depth, which has a temperature of less than 0° for a distance of 120 miles east of Sakhalin Island. The surface temperature over this area is from

9° to 12°. At the same time the density of the cold body is greater than that of the warm body above it. Generally high temperatures are accompanied by a high degree of salinity.

The explanation as given by the author is found in the fact that the surface of this body of water freezes over during the course of the severe winters. This takes place, however, only after the surface temperature has been reduced to —1.7°, and the whole body of water to a depth of 200 metres has then a temperature below 0°. In the process of freezing the salts are largely excluded from the upper layer, and produce an excessive amount in the lower one. In the summer, when the ice melts, it does not reabsorb these salts, and its low salinity is intensified by the addition of fresh water from the rivers, and notably, according to Makarov, from the Amur. The current from this river passes around the north point of the island, and then down its east coast.

The slight depth of the warm water in the summer time is explained by the statement that, on account of the low salinity, there is no exchange between the upper and lower layers during the process of evaporation, and that in general the absence of currents prevents a general mingling of the layers.

In the greatest depths (600–800 metres) a temperature of 2.4° was found, and since this corresponds to a depth of 1,500 metres in the open ocean, we can take it for granted that this depth is not exceeded in any of the straits between the Kurile Islands.

The density of the water of this sea increases constantly with the depth to 1.02254. Here again it is seen that temperature and density increments come from the side and not from the surface of the water, and the question arises whence does this body receive these additions, from the main Pacific Ocean or the Japan Sea? Makarov seems to think that the source is to be found in the Japan Sea, but the facts do not seem to point to an exchange of waters at this point, but rather to a conflict. On account of the depths between the Kurile Islands less difficulties are placed in the way of an exchange than we find in the Strait of La Perouse. That the exchange does not take place from the main ocean may be due to the slight differences in the physical characters of the two bodies of water.

The work of Moser in 1896 reinforces the conclusions of Makarov, that the main source of supply is to be found in the Sea of Japan. The warmer and denser water after leaving the Strait of La Perouse turns eastward, and at about 50° N. Lat. disappears from the surface, being gradually overflowed by the colder water.

Temperature observations on the east of the Kurile Islands go to show that no warm currents reach these coasts, and the barrier presented by this chain of islands to the free passage of the tides prevents a mixture of the surface layers, and consequently depresses the temperature of the surface.

III.—Central Pacific Ocean.—Mr. Lindenkohl constructs a diagram giving a section of the Pacific, east of the Hawaiian Islands, as based upon the *Challenger* observations in 1875 between 20° 38′ N. and 13° 28′ S. Lat. The profile shows, what has generally been accepted as the case, that the southern Pacific is warmer, as well as more dense, than the northern. This is probably due to the non-existence of any single great current.

The maximum density (1.0276) in the southern Pacific is found at about 20° S. Lat. near the Society Islands. In general a decrease in density (1.0254–1.0257) is noticed to a depth of 550 metres, and then an increase towards the bottom, where the density is 1.0259. This depth (550 m.) would seem to indicate the limit of the introduction of salts and warmth from the surface, due to evaporation, etc.

There is another cause, however, which produces vertical motion in a body of water and consequently redistributes both of these elements of salt and warmth. Two bodies of water, of different degrees of salinity, can only be in equilibrium when the more saline has a higher temperature. When two such bodies come into contact and an exchange begins, the warmer shows a tendency to sink, and the colder to rise. We find, in fact, that the water of the south Pacific, with a density of from 1.0259 to 1.0260, which nowhere attains the depth of 370 metres, sinks to a depth of 1,500 metres, in the neighborhood of the Equator. On the other hand, at 20° N. Lat., on the northern border of the equatorial current, at a depth of 1,500 metres, water with a density of 1.0254 is found rising obliquely towards the Equator. At 3° N. Lat. with a density increased to 1.0258 it comes within 100 metres of the surface, where it has the effect of reducing the density of the surface to 1.0260.

A consequence of the sinking of this denser water near the Equator, is that at that point and to about 10° N. Lat. higher temperatures are found at all depths beyond 300 metres than at any position further north or south.

The rise of less saline water causes a reduction of the temperature of the water directly under the Equator

A similar series of phenomena culminating at the surface at about 10° N. Lat. is also to be noticed on the diagram.

Horizontal currents, both surface and at certain depths, and in different directions, make the problem more complex, and make the facts as given by the diagrams appear contradictory, but their explanation becomes easy when the conditions are taken into account.

PRELIMINARY REPORT UPON THE PHYSICAL INVESTIGATIONS MADE IN THE RED SEA. BY JOSEPH LUKSCH. (*Sitzungsberichte der Wiener Akademie der Wissenschaften, 1898, Vol. CVII, Abth. I, p. 609.) Reviewed in Naturwissenschaftliche Rundschau 1899, Vol. XIV, p. 25.*

The Austrian Expedition on the *Pola* to the Red Sea under the command of Paul von Pott, with a staff of scientific co-workers, appears to have done a considerable amount of work.

The isobathic line of 200 metres lies very close to the mainland, where the shallow shore waters are separated from the deep water by a narrow coral zone—beyond which the depth increases rapidly. The deepest portion was found to be 2,176 metres, at 20° 2′ N. Lat. and 38° 20′ E. Long.

There is an interesting section upon the coral reef region.

The results of the elaborate series of temperature and density observations may be summarized as follows:

(1) The general temperature of the sea (with due allowance for the season) is relatively high, sometimes higher than in the northern portion of the Red Sea. The specific gravity is, however, as a rule, lower.

(2) The temperature and specific gravity decrease from the surface towards the bottom. From the 700-metre line downward there is no appreciable change in the temperature, and the thermometer remains at 21.5° C. (70.7° Fahr.) from this point to the bottom.

(3) The waters on the Arabian Coast are warmer and more saline than those on the African side.

(4) On both coasts the temperatures increase from north to south, while the densities decrease.

(5) A daily variation in temperature was perceptible to a depth of 100 metres.

(6) The highest temperatures observed were 32.5° C. (90.5° Fahr.) on the surface, and 31.8° C. (89.24° Fahr.) at the bottom in 10 metres of water.

The lowest temperatures were 23° C. (73.4° Fahr.) on the surface, and 22.8° C. (73.04° Fahr.) at a depth of 14 metres.

The highest specific gravity was 1.03115, representing 4.08 per cent. salt.

Many observations were made upon the transparency and color of the water, by photographic methods and by the lowering of white plates. While the transparency of the northern portion was found to be less than that of the Mediterranean, this relation was found to be progressively greater to the south. The greatest visible depth in the northern basin was found to be 50 metres, whereas in the southern a depth of 39 metres was attained but once, and the general depth was 30, 20 or 10 metres. According to the Forel color scale the numbers 1 and 2 (99 and 98 blue, and 1 and 2 yellow) were wanting, while No. 10 (70 blue and 30 yellow) was obtained. In the northern basin the numbers 6 and 10 were never found.

How far the local conditions were modified by the meteorological phenomena has not been determined as yet. The currents, as far as they could be determined by the temperature and density relations, correspond with those of the northern basin. There was little opportunity for the measurement of waves, but in general it was noticed that the movement of the water became established quickly in deep water, whereas it was very irregular in the coral regions.

INSTRUMENTS.—The older forms of sounding tubes have often been found defective, and for a variety of reasons.

1. They were not always air-tight, and by the escape of the air gave indications of depths which were too great. Minute cracks in the sealing substance, not appreciable to the naked eye, could only be detected by using the tubes in known depths, or subjecting them to pressure.
2. Inequalities of calibration also have given rise to errors. Where the lumen of the upper end of the tube was larger than that at the lower end, the depths obtained were too great, and *vice versa*.
3. The admission of moist air of low density to the tubes further gave rise to errors when these instruments were used in water of still lower density, such as is to be found in the mouths of rivers, etc.

New tubes have been constructed by R. Füss, which have been

hermetically sealed at both ends. This insures their being air-tight for sounding purposes, and prevents the admission of air during storage. The smaller portion of the tube is taken for its upper end, which secures a safe margin of error—if there must be one—in the depth, as it is better to have the recorded depth too small than too great. This error is, however, not allowed to exceed five per cent. A short piece is broken off from the end of the tube when it is to be used. Tests of both new and old instruments have been made by the German Marine Office, which show that these new instruments are much more reliable than the old ones, giving depths in every instance to within a half metre whereas the old ones varied considerably.

*Note.*—It has also been found that results obtained are most reliable when the barometer stands between 730.24 mm. and 749.29 mm. (28.75 in. and 29.50 in.), otherwise a correction must be applied—*i. e.*, one fathom should be added to all depths when the barometer reads higher than given above.

(*Annalen der Hydrographie und Maritimen Meteorologie, Vol. 27, p. 50.*)

EXPEDITION OF THE *Valdivia* UNDER PROF. CHUN.—Abstract of a letter published in the *Vossische Zeitung*, Jan. 1. Notice in *Naturwissenschaftliche Rundschau, Vol. XIV., p. 38.*

After a description of the trip to Ambas Bay, the mouth of the Congo, etc., the main portion of the letter which is of importance relates to the trip from this point southward. In this region the deep-sea net gave evidence of a bottom consisting of blue-grey or black mud, with a very scanty fauna.

On October 17th, however, at 25° 26′ S. Lat. and 6° 12′ E. Long., the conditions changed very decidedly. Previous expeditions in this region had reported considerable depths, and an "intermediate" net was let out at a depth of 2,000 metres, which, however, touched the bottom. When the trawl net was lowered, an unprecedented catch was secured of the most interesting forms. This is generally the case with all such elevations or "banks" in the oceans. The variety of forms of life was very exceptional both as to number and quality. Many new species were secured, and many animals heretofore considered surface forms were found to have representatives in deep water.

In Fish Bay only the economic species were carefully studied. The abundance of the fish useful in commerce is very noteworthy in this locality. Their numbers can probably be accounted for by the richness of the colder waters in organic life. The abundance

of fish further determines the great number of birds to be found here, only comparable with our northern regions.

After their arrival in Cape Town, a ten days' trip was made to the Agulhas Bank. A preliminary report was made of work upon this bank, in which much is made of the difficulties encountered on account of the rocky character of the bottom.

The previous expeditions of the *Challenger* and the *Gazelle* located this bank at the point of contact of the Indian, Atlantic and Sub-Antarctic currents, and assigned it a special position in its relations to the distribution of animals. It was, therefore, interesting to note, among the finds of this expedition, forms directly related to northern species, among the strange new ones.

The material collected at this point by the *Valdivia* Expedition, coming from all depths, will be of great value to biologists in a number of different directions.

According to the *Geographical Journal, Vol. XIII., 1899, p. 297*, the soundings of the *Valdivia* expedition will be of especial value in filling gaps in the charts.

In the neighborhood of Enderby Island, dredgings were made in 2,541 fathoms, which brought up a number of stones, which were not of volcanic origin. The depth of this part of the Antarctic basin is particularly striking, being much greater than was supposed.

An island in 54° 26′ S. Lat. and 3° 24′ E. Long. was approached. It is doubtful whether it was Bouvet, Lindsay, or Thompson Island. It appears to be a volcanic crater, covered with a glacial cap.

Sub-Oceanic Physical Features of the coast of Western Europe. Prof. Hull, *Geographical Journal, Vol. XIII, No. 3 (1899), p. 285.*—Based upon the fact that the 100-fathom platform of northern Europe is the submarine foundation from which the British Isles rise, Prof. Hull has read a paper before the Royal Geographical Society upon the subject of the physical features of this platform. The paper certainly had the merit of provoking discussion. It sought to show that this platform was traversed by ancient river valleys, which were inferentially traceable to the rivers which drain the adjacent lands at the present time.

The paper is a continuation of the discussion of the same subject by Prof. Hull in the *Journal of the Victoria Institute, Vol. XXX, p. 305.*

The proofs adduced in evidence of the channels being river beds are as follows:

1. A continuous deepening of the channel in the direction of the outlet.

2. Continuous widening of the channel in the same direction.

3. A winding course, unlike that of faults or fissures.

4. Lateral branches descending from adjoining land on either hand.

The continuity of the ancient channels with those of existing rivers is most clearly seen in the cases of the Adour and Tagus, though many others were traced off the coasts of England, France, Spain and Portugal.

The paper was followed by a very able and thoroughly interesting discussion, which reminds one of the storm that greeted the first announcement that the Colorado Cañon and some other portions of our own continent were due to sub-aerial erosion. The strongest among those who opposed the interpretations of Prof. Hull urged caution as to the hasty adoption of theories upon a slender basis of fact. More actual soundings are needed before such results can rest upon a secure basis.

That such cuts do exist on our side of the water is hardly to be doubted, but whether they have not been assisted by the fracture of the earth's crust, still remains to be proved. An illustration might be found bearing on this point in the sub-marine extension of the Hudson River channel to the edge of the continental platform. Such cuts, if they exist, must have been produced by sub-aerial erosion and they have their splendid counterparts in our southwestern territory. But the consequences from a geological point of view would be interesting, such as the elevation of the whole English Channel area through a distance of 6,000 feet, even if there seems to be good reason for it when comparisons are made with other areas, as was shown by Prof. Hull in his reply to his critics.

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